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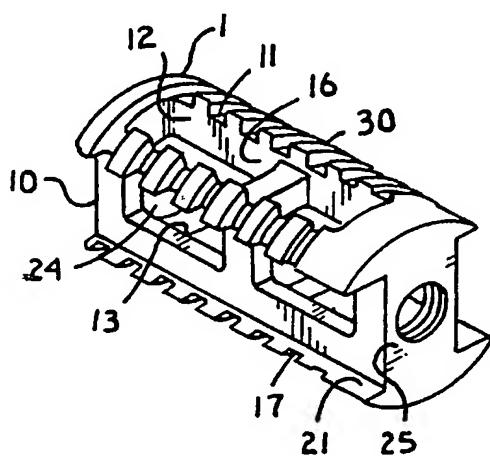
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: THREADED FUSION CAGE WITH ENHANCED ANTERIOR SUPPORT



(57) Abstract: A fusion cage (1) is disclosed in the present application. The cage (1) has an overall generally cylindrical shaped body (10) with portions removed and with an outer surface (11) located on and defined by an exterior of a wall (12). An inner chamber (13) is also defined by an interior of the wall (12). The wall (12) includes upper and lower fenestrations of windows and (17) as well as side windows (20). The sides of the cage body (10) are truncated and channeled to produce channels (21) and (22) so as to reduce weight and size and to allow for mating with a tool. The front wall (25) allows for the packing of the chamber (13) during the installation process. The thread (30) is discontinuously wound around the surface (11) and gradually decreases in depth as it approaches the front wall (25).

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THREADED FUSION CAGE WITH ENHANCED ANTERIOR SUPPORTBackground of the Invention

1 The present application is directed to a fusion cage
2 for use as a spinal implant between a pair of vertebrae
3 in order to provide support to and subsequently promote
4 the fusing together of the vertebrae and, in particular,
5 a threaded fusion cage having a thread that is feathered
6 near an anterior end of the fusion cage, such that a
7 minor diameter of the thread approaches a major diameter
8 of the thread near the anterior end.

9 Fusion cages are commonly implanted between a pair
10 of vertebrae of the spine in order to provide support to
11 the vertebrae and to eventually promote fusion between
12 the vertebrae. Fusion cages are generally of two types
13 which are rectangular in cross-section or circular in
14 cross-section. The present application is directed to
15 the latter type which are overall generally cylindrical
16 in shape and threaded so as to provide a better grip for
17 the cage upon implantation. The threaded cages are
18 normally inserted between vertebrae where the disc
19 between the vertebrae has been removed and a partial bore
20 has been provided by drilling or the like. Normally, the
21 fusion cages will have windows extending between the top

1 and bottom thereof to allow bone to grow through and fuse
2 together between the vertebrae. Also the interior of the
3 fusion cage is often packed with bone or other matrix
4 that encourages the growth of bone into the cage and
5 between the two vertebrae and, therefore, a subsequent
6 fusing therebetween.

7 The facing surfaces of the vertebrae between which
8 the cages are inserted are mostly of a relatively soft
9 spongy bone. Because of this, the cages are subject to
10 subsiding into the bone either very soon after surgery or
11 at a later date. Such subsidence is undesirable.

12 While the majority of the bone adjacent the facing
13 surfaces of the vertebrae is spongy and somewhat soft, a
14 comparatively narrow band of bone at the anterior of each
15 vertebrae is comparatively harder bone. It is, therefore,
16 desirable to take advantage of this harder bony region by
17 improving the contact of the fusion cages, as much as
18 possible, in this region and reducing structure into
19 which the bone can subside.

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Summary of the Invention

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3 A fusion cage has a cylindrical or partially
4 cylindrical shape with a pair of semi-circular surfaces
5 on opposite sides thereof that are sized and shaped to
6 engage facing surfaces of a pair of vertebrae that are to
7 be supported and fused by the fusion cage. The fusion
8 cage surfaces include a thread thereon that may be
9 continuous about the fusion cage, but is normally only on
10 the surfaces that engage the vertebrae during actual use
11 and, in such cases, a complementary thread may be
12 provided by an insertion tool to allow the device to be
13 threadedly advanced into a bore located between the two
14 adjacent vertebrae. For example, see U.S. Patent
15 5,865,847 of Kohrs et al. which is incorporated herein by
16 reference.

17 The thread has a major diameter and a minor
18 diameter. Over most of the length of the cage and
19 especially near the posterior end of the cage, the minor
20 diameter is substantially less than the major diameter
21 thereby forming a series of peaks and valleys
22 constituting the threadform. The major diameter of the
23 thread stays generally constant along the entire length
24 of the thread. The thread depth remains generally
25 constant near the posterior end and middle of the cage,

1 but is reduced near the anterior end of the cage.
2 In particular, located near the anterior end of the
3 cage and sized and positioned to engage an anterior
4 surface of comparatively harder bone near the anterior of
5 the vertebrae is a modified thread. In the modified
6 thread the minor diameter approaches and preferably
7 equals the major diameter at the front or anterior end of
8 the cage to effectively reduce the thread depth in this
9 region. Preferably, the minor diameter over a short
10 distance approaches the major diameter evenly or
11 progressively, as the threadform winds discontinuously,
12 but in a helical form or pattern about the cage. Also
13 preferably the increased minor diameter occurs over
14 approximately at least the front 1/4 inch of the thread,
15 while the major diameter remains constant. Further, the
16 minor diameter is preferably approximately equivalent to
17 or the same height as the major diameter between the
18 final two passes of the threadform near the anterior end
19 of the cage so as to present a generally smooth
20 cylindrical or semi-cylindrical surface in this region.

1 Objects and Advantages of the Invention

2

3 Therefore, the objects of the present invention are:
4 to provide a fusion cage for implantation between a pair
5 of vertebrae, so as to provide support and fusion between
6 the vertebrae, and that resist subsidence into the
7 vertebrae by providing as much support as possible near
8 an anterior end of the fusion cage whereat the fusion
9 cage engages a harder bony region of the vertebrae; to
10 provide such a cage that is generally cylindrical in
11 shape and threaded; to provide such a cage having a
12 thread with a major diameter and a minor diameter that is
13 helical in form, but is not continuous, that is wound
14 about the cage; to provide such a cage wherein the thread
15 is feathered near the anterior end of the cage by
16 increasing the minor diameter of the thread, while
17 maintaining the major diameter constant, until the minor
18 diameter approaches or equals the major diameter of the
19 thread, so as to reduce thread depth at the anterior end
20 of the cage; to provide such a cage having a generally
21 smooth cylindrical surface at the anterior end thereof
22 that is at least the equivalent of several thread turns
23 in width; and to provide such a cage wherein the minor
24 diameter of the thread is allowed to increase evenly and
25 progressively over approximately 1/4 of an inch length of
26 the cage until it approaches or is equal to the major

1 diameter; to provide such a cage which is comparatively
2 easy to construct, easy to use and especially well
3 adapted for the intended purpose thereof.

4 Other objects and advantages of this invention will
5 become apparent from the following description taken in
6 conjunction with the accompanying drawings wherein are
7 set forth, by way of illustration and example, certain
8 embodiments of this invention.

9 The drawings constitute a part of this specification
10 and include exemplary embodiments of the present
11 invention and illustrate various objects and features
12 thereof.

13

14 Brief Description of the Drawings

15

16 Figure 1 is a perspective view of a fusion cage in
17 accordance with the present invention.

18 Figure 2 is a side elevational view of the fusion
19 cage with portions broken away to show detail thereof.

20 Figure 3 is a side elevational view of the fusion
21 cage mounted between a pair of vertebrae that are shown
22 in phantom.

23 Figure 4 is a front elevational view of the fusion
24 cage positioned between a pair of vertebrae that are
25 shown in phantom.

26 Figure 5 is a perspective view of a modified fusion

1 cage in accordance with the present invention.

2 Figure 6 is a side elevational view of the modified
3 fusion cage with portions broken away to show detail
4 thereof.

5 Figure 7 is a side elevational view of the fusion
6 cage mounted between a pair of vertebrae that are shown
7 in phantom.

8 Figure 8 is a front elevational view of the fusion
9 cage positioned between a pair of vertebrae that are
10 shown in phantom.

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12 Detailed Description of the Invention

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14 As required, detailed embodiments of the present
15 invention are disclosed herein; however, it is to be
16 understood that the disclosed embodiments are merely
17 exemplary of the invention, which may be embodied in
18 various forms. Therefore, specific structural and
19 functional details disclosed herein are not to be
20 interpreted as limiting, but merely as a basis for the
21 claims and as a representative basis for teaching one
22 skilled in the art to variously employ the present
23 invention in virtually any appropriately detailed
24 structure.

25 The reference number 1 generally designates a fusion
26 cage in accordance with the present invention. The

1 fusion cage 1 is normally used side by side in pairs
2 located between a pair of adjacent vertebrae 5 and 6, as
3 seen in Figure 3.

4 The cage 1 has an overall generally cylindrical
5 shaped body 10 with portions removed, as described below,
6 and with an outer surface 11 located on and defined by an
7 exterior of a wall 12. An inner open chamber 13 is also
8 defined by an interior of the wall 12.

9 In the illustrated embodiment the wall 12 includes
10 upper and lower fenestrations or windows 16 and 17, as
11 well as side windows 20.

12 The sides of the cage body 10 are truncated and
13 channeled to produce channels 21 and 22 so as to reduce
14 weight and size and to allow for mating with a tool (not
15 shown) used in a well known process for inserting the
16 cage 1 between the vertebrae 5 and 6.

17 The cage 1 also has a rear wall 24 and a front wall
18 25. The front wall 25 includes an aperture or threaded
19 bore 26 that allows for the packing of the chamber 13
20 during the installation process. The packed bore and
21 other growth promoting matrix enhance the fusion of the
22 bone of the vertebrae 5 and 6 through the windows 16 and
23 17.

24 Formed on the cage surface 11 is a thread 30. The
25 thread 30 is discontinuously wound about the surface 11
26 in a helical pattern and mates with similar thread on a

1 tool (not shown) for purposes of insertion after which
2 the tool is removed. It is noted that in accordance with
3 the invention, the thread 30 can have varying degrees of
4 discontinuity depending upon the particular type of
5 cylindrical threaded cage used. That is, some such cages
6 have outer surfaces that are continuous or almost
7 continuous, while others have more windows and other
8 openings. The thread 30 of this embodiment has an outer
9 radius and an inner radius and is somewhat step-like or
10 square in form. The thread outer radius remains
11 generally constant throughout the length of both the
12 thread 30 and the cage 1.

13 The thread inner radius remains constant over a
14 posterior 33 portion and a middle portion 34 of the cage
15 1, but varies near a front or anterior portion 35 so as
16 to vary the thread depth in the cage anterior portion 35
17 as compared to the rest of the cage 1.

18 In particular, the minor radius approaches or equals
19 the major radius over at least part of the anterior
20 portion 34. Preferably, the minor radius or the bottom
21 of the thread increases radially outward evenly or
22 progressively over two or three turns of the thread 30 at
23 or near the anterior end of the cage 1. That is,
24 preferably, the thread depth is feathered over the last
25 few turns to reduce the depth and to provide greater
26 support to bone adjacent thereto and reduce the

1 likelihood of subsidence of the cage 1 into the bone. As
2 used herein, the term turn means a single, but
3 discontinuous, pass of the thread 30 in a 360° arc around
4 the cage 1. Thus, the thread inner diameter or radius
5 keeps increasing in the anterior portion 35 as the thread
6 30 approaches the front of the cage 1. Also, preferably,
7 the inner diameter equals the outer diameter over the
8 last two turns of the thread 1, so as to produce a
9 generally smooth cylindrical surface 38. The thread 30
10 minor radius preferably increases over about the forward
11 or anterior one fourth inch of the cage 1.

12 In use the cage 1 is inserted, as a side by side
13 generally parallel pair, between the vertebrae 5 and 6
14 after removal of a pad therebetween and boring between
15 the vertebrae 5 and 6 to create an opening approximately
16 the shape of the cage outer surface 11. Each vertebrae 5
17 and 6 has an anterior relatively hard boney region 41 and
18 42 respectively. The cage 1 is positioned such that the
19 thread anterior portion 26, where the thread depth is not
20 as great because the minor radius is increased in
21 comparison to the rest of the thread, is located in
22 abutting relationship to the regions 41 and 42. The
23 cylindrical surface 38 is especially located to support
24 the regions 41 and 42 on either side of the cage 1.

25 Shown in Figures 5 through 8 is a second embodiment
26 of a fusion cage 100 in accordance with the present

1 invention. The cage 100 is similar in many aspects to
2 the cage 1, so that the same features will not be
3 reiterated in detail, but rather reference is made to the
4 first embodiment for greater detail.

5 The cage 100 is shown positioned between two
6 vertebrae 105 and 106 in Figs. 6 and 7. Normally, a pair
7 of the cages 100 is used in parallel spaced relationship
8 or with a slight toe in or toe out with respect to one
9 another.

10 The cage 100 has a body 110 with a windowed, but
11 otherwise generally cylindrically shaped outer surface
12 111, defined by a wall 112. The wall also defines an
13 inner chamber 113. Four evenly spaced windows 116 extend
14 between the outer surface 111 and chamber 113. The cage
15 has a rear wall 124 and a front wall 125 with a bore 126
16 therein.

17 A thread 130 is wrapped about the length of the cage
18 1. The thread 130 is laid in a helical pattern, but is
19 discontinuous at the windows 116.

20 The thread 130 of the present embodiment is V-shaped
21 as opposed to the step or square threadform of the
22 previous embodiment.

23 The thread 130 is tapered or feathered near the
24 anterior end 140 of the cage 1. In particular, the
25 thread 130 has a rear portion 133, a middle portion 134
26 and a front or anterior portion 135. In the rear portion

1 133 and the middle portion 134 the thread 130 has a
2 generally constant or uniform thread depth between the
3 major and minor radii of the thread 130. Whereas, the
4 thread depth of the thread 130 in the anterior portion
5 135 approaches or equals zero or no depth. Preferably
6 the minor radius of the thread 130 increases
7 progressively in the front portion 135 for several turns
8 until the minor radius equals the major radius very near
9 the anterior end 140 of the cage 1 and preferably at
10 least over the last turn of the thread 130, so as to
11 provide a generally smooth cylindrical surface 138 in
12 this region to resist subsidence into the vertebrae 105
13 and 106. The surface 138 is especially sized, shaped and
14 positioned during use to engage or abut the harder boney
15 regions 141 and 142 of the vertebrae 105 and 106.

16 It is to be understood that while certain forms of
17 the present invention have been illustrated and described
18 herein, it is not to be limited to the specific forms or
19 arrangement of parts described and shown.

C L A I M S

What is claimed and desired to be secured by Letters Patent is as follows:

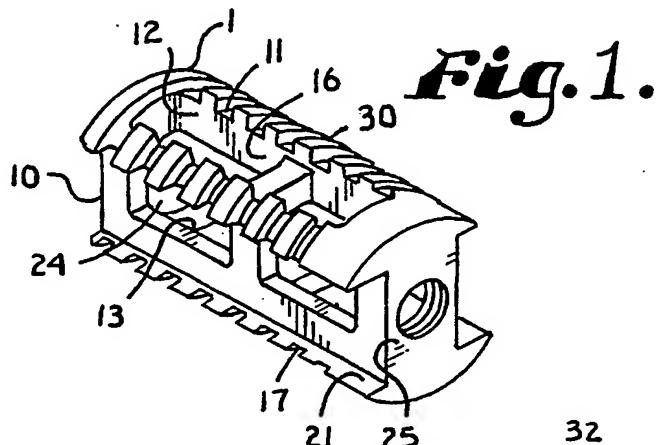
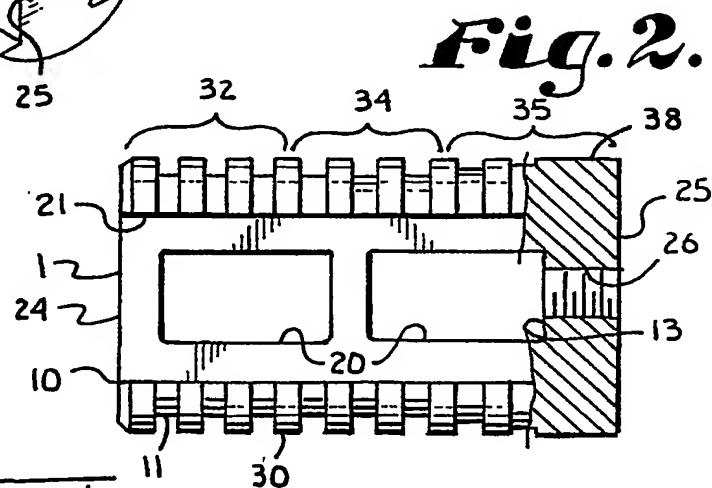
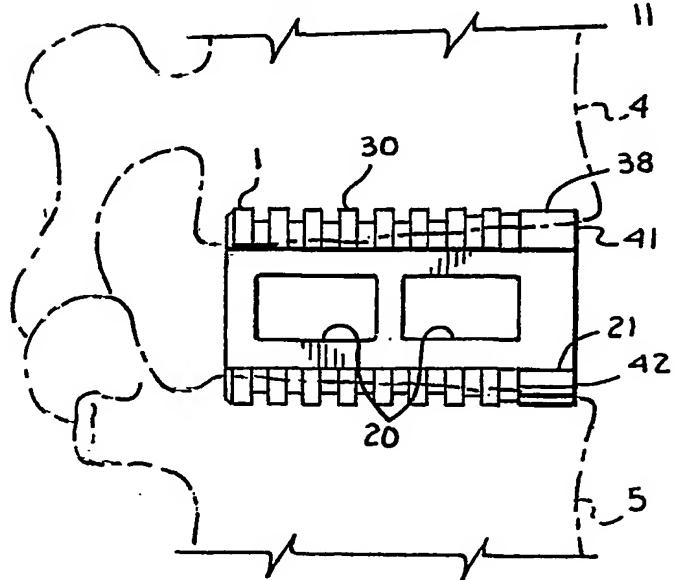
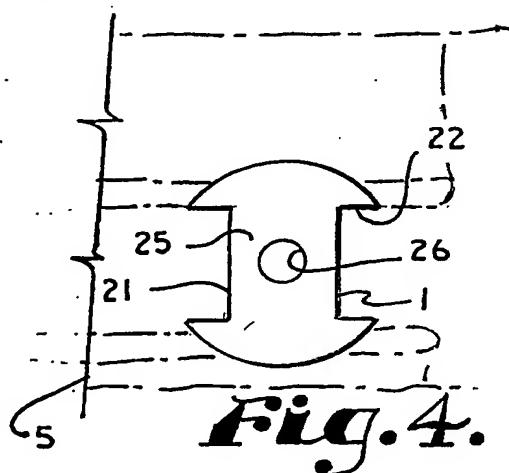
1. A spinal fusion cage for implantation between a pair of vertebra; said cage comprising:
 - a) an elongate body having semi-circular surfaces on opposite sides thereof that are sized and shaped such that each of said surfaces is adapted to engage a respective vertebra when positioned therebetween;
 - b) each of said surfaces including a portion of a radially outward extending thread for engaging a respective vertebra;
 - c) said thread having a major diameter and a variable minor diameter; said thread minor diameter increasing and approaching said major diameter near an anterior end of said cage so as to reduce thread depth and to provide greater support to the anterior end of vertebrae during usage.
2. The cage according to Claim 1 wherein:
 - a) said cage is generally cylindrical in

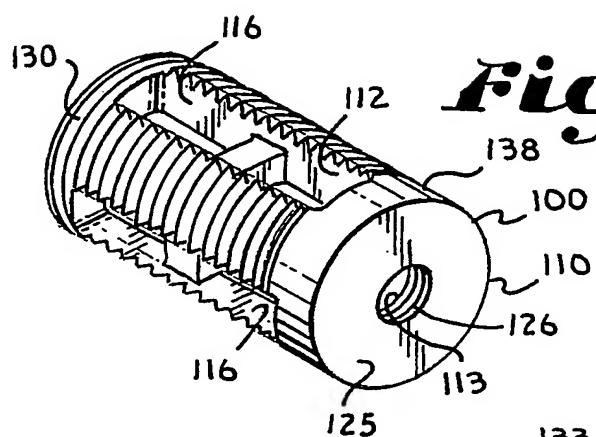
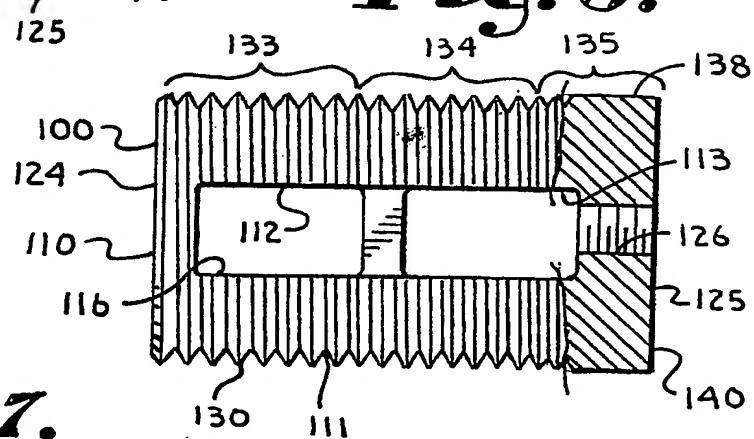
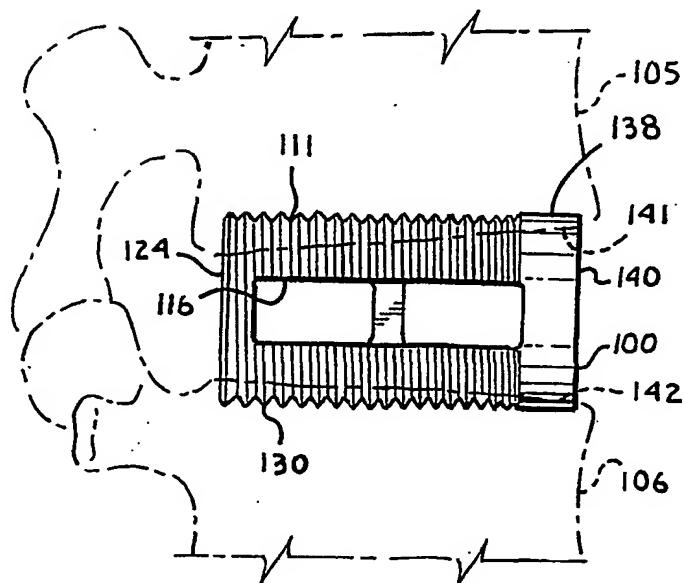
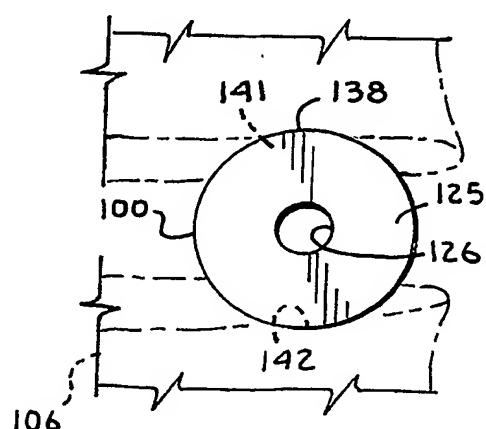
overall shape and said surfaces each include windows passing therethrough.

3. The cage according to Claim 1 wherein:
 - a) said cage is a truncated cylinder with opposed semi-circular sections removed and said semi-circular surfaces are noncontinuous with each other.
4. The cage according to Claim 3 wherein:
 - a) said threads are noncontinuous between said semicircular surfaces.
5. The cage according to Claim 1 wherein:
 - a) said thread is wound in a discontinuous helical pattern about said cage.
6. The cage according to Claim 5 wherein:
 - a) said major diameter is generally constant and said minor diameter increases uniformly along a length of said thread located near the front of said cage.
7. The cage according to Claim 6 wherein:
 - a) said length over which said minor diameter increases is approximately three turns of

said thread about said cage.

8. The cage according to Claim 6 wherein:
 - a) said minor diameter increases over approximately the anterior one fourth inch of said cage to approximately the diameter of said major diameter.
9. In a threaded fusion cage wherein a thread thereon has a minor diameter and a major diameter; the improvement comprising:
 - a) increasing the minor diameter of said thread near an anterior end of said cage to approximate said major diameter so as to reduce thread depth.
10. The cage according to Claim 9 wherein:
 - a) said major diameter is generally constant and said thread is anteriorly feathered to progressively increase said minor diameter along said thread to said major diameter near the anterior end of said cage.
11. The cage according to Claim 10 wherein:
 - a) said thread is anteriorly feathered for approximately one fourth inch.

**Fig. 1.****Fig. 2.****Fig. 3.****Fig. 4.**

**Fig. 5.****Fig. 6.****Fig. 7.****Fig. 8.**

INTERNATIONAL SEARCH REPORT

Inter: Application No.
PCT/US01/09926**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) A61F 2/44

US CL :623/17.16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 623/17.16, 17.11

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US 5,968,098 A (WINSLOW) 19 October 1999 (19.10.1999), see the entire document.	1, 2, 5, 6, 9, and 10 ----- 3, 4, 8, and 11
Y	US 5,609,636 A (KOHRS et al) 11 March 1997, see the entire document.	3 and 4

 Further documents are listed in the continuation of Box C. See patent family annex.

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